PRELIMINARY EVALUATION OF HRRR 2012 WARM SEASON EVALUATION

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1. INTRODUCTION AND RETROSPECTIVE TESTING

This is a preliminary report of the HRRR configuration, reliability and performance for the 2012 warm season evaluation period. Following completion of the 2011 warm season evaluation period on Oct. 31, 2011, work commenced to test a variety of changes to both the HRRR and parent Rapid Refresh (RAP) systems in anticipation of the 2012 code freeze that occurred on March 15, 2012. A focus of this testing was on changes to the RAP, as a number of desirable enhancements to the RAP system were identified during the course of the spring and summer 2011 (following the code freeze for the 2011 in late April 2011). These enhancements addressed boundary layer moisture bias and other issues that out tests indicated were associated with a high bias in HRRR storm coverage (and associated spurious occurrence of convection) in the 2011 HRRR forecasts. Other changes were designed to help address the long standing difficulty in reproducing bow echo storm systems (common in the 2011 HRRR and in most storm-scale models). Also included in these changes was an update to both the WRF-ARW model and GSI analysis package to more recent versions from the community-based SVN repository (a yearly occurrence to make sure the RAP and HRRR system continue to incorporate the latest contributions from the WRF ARW and GSI development communities).

The testing strategy included evaluating individual changes in individual runs and in some case for short periods within the RAP / HRRR real-time parallel runs. Once a final overall package was set, a final test included completing two multi-day retrospective evaluations of the 2012 combined RAP / HRRR system compared to the real-time 2011 results. The two retrospective test periods were:

29 May – 12 June 2011 (160 matched runs)

11 Aug. – 22 Aug 2011 (135 matched runs)

295 total matched runs

~ 22-24 matched runs for each initialization hour

The final set of changes is detailed as the red items in Fig. 1.

RAP/HRRR Changes for 2012

		Model	Data Assimilation
Red = Changes in current RAP / HRRR effective before 09 March 2012	RAP (13 km)	WRFv3.3.1+ Physics changes (convection, microphysics, land-surface, PBL) Numerics changes (w-damp upper bound conditions, 5th-order vertical advection) MODIS land use, fractional 30→10 min shortwave radiation New reflectivity diagnostic	Soil adjustment, Temp-dep radar-hydrometeor building PW assim mods Cloud assim mods Tower/nacelle/sodar observations GLD360 lightning GSI merge with trunk
	HRRR (3 km)	WRFv3.3.1+, Physics changes (microphysics, land-surface, PBL) Numerics changes (w-damp upper bound conditions, 5th-order vertical advection) MODIS land use, fractional 30→05 min shortwave radiation New reflectivity diagnostic	

Fig. 1 Set of changes to RAP and HRRR model and data assimilation included in the updated version used for the 2012 warm season evaluation.

As reported previously, results from these retrospective tests were very encouraging, with significantly reduced bias, and enhanced skill at predicting the location, and especially the structure of convection. In particular, bow echo events within the retrospective periods were significantly better handled by the 2012 RAP / HRRR configuration.

2. 2012 HRRR RUN RELIABILITY

During the 2012 warm season real-time evaluation the RAP / HRRR real-time experimental system ran with good reliability as shown in Fig. 2, comparison with the exclusion of two or fewer consecutive missed runs. Allowance for this amount of missed runs would allow for no interruption of shorter duration products (out to 8 h) products, even allowing for a greater than 2h latency in the receiving and processing of input HRRR forecast grids. As can be seen, the HRRR availability is 90% or greater for all months during the 2012 summer evaluation (rightmost red bars).

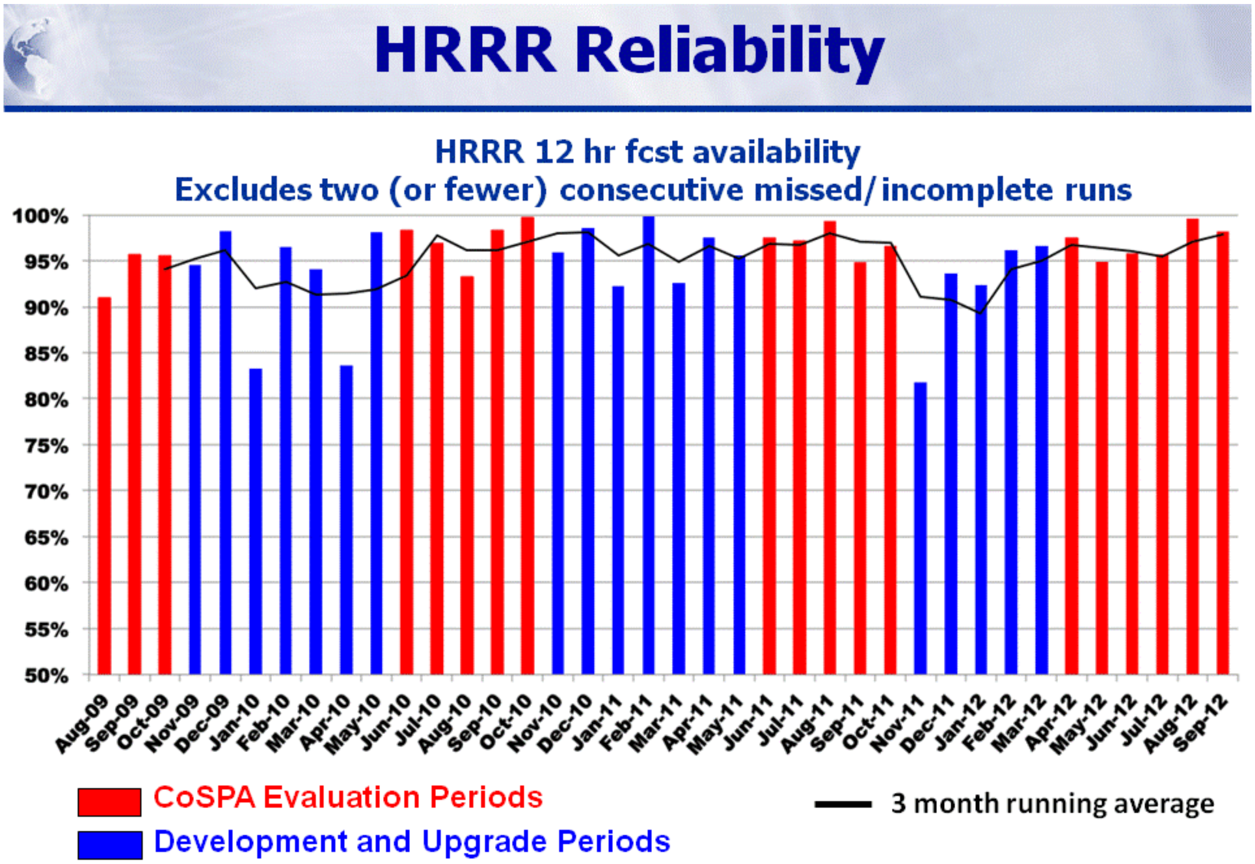

Fig. 2 HRRR reliability by month with allowance for up to two consecutive missed runs. Red indicates months during real-time evaluation periods and blue indicates development periods .

3. 2012 HRRR FORECAST SKILL STATISTICS

As noted in Sect. 2, direct retrospective experiment comparison of the 2012 vs. 2011 forecast skill for matched events (not shown) indicated a clear superiority for the 2012 RAP / HRRR system. We have also completed a long term (4 month) quantitative comparison of the 2012 vs. 2011 RAP / HRRR system, each verified during the period from June 1 through Sept. 30 of the warm season for which they were run in real-time (2011 for the 2011 system and 2012 for the 2012 system). We note that the verification periods between the runs being compared have no overlap, and that significant differences in the convective activity between the 2011 and 2012 season could affect the results. However, because of the extremely long verification period (hourly runs over 4 months), we should be able to draw meaningful conclusions from this comparison. Fig. 3 shows this comparison as a function of forecast length for CSI and bias of 25 dBZ reflectivity up-scaled to a 40-km domain (to provide a better estimate of "neighborhood" skill). As can be seen the 2012 HRRR exhibits higher forecast skill (as measured by the CSI) for all forecast lead time through 15 h. Note that the 0-h analysis superiority for the 2011 HRRR is a cosmetic difference associated with the specification of snow hydrometeors from radar reflectivity data in the 2011 system.

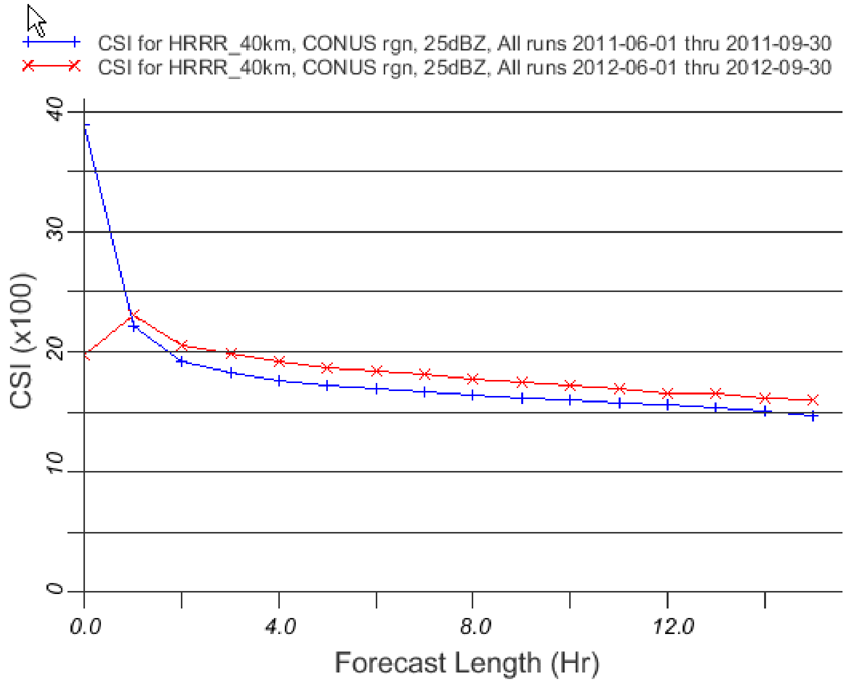

Fig. 3

2012 HRRR (red curve) vs. 2011 HRRR (blue curve) CSI skill score (X 100) as a function of forecast length for 25 dBZ radar reflectivity threshold, up-scaled to a 40-km grid.

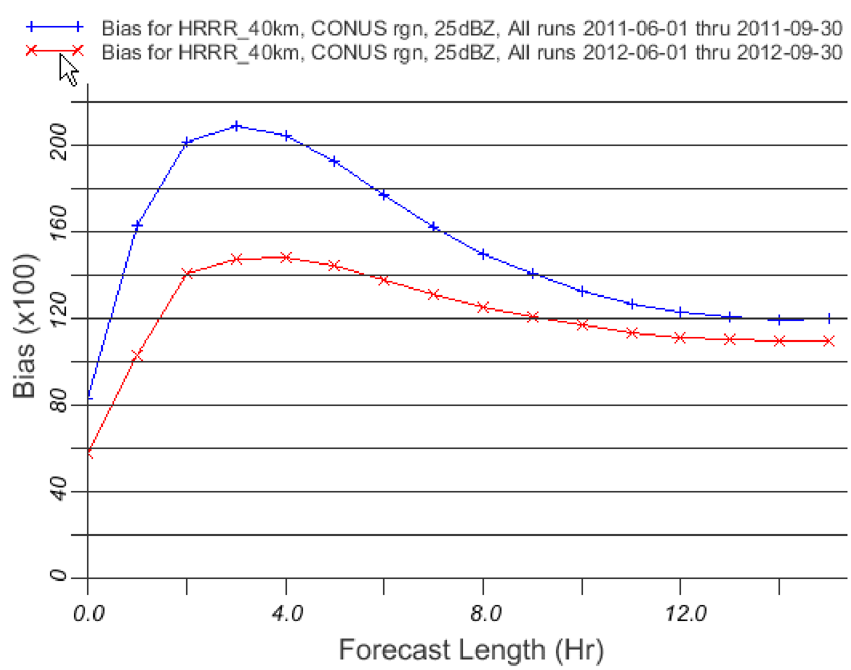

Fig. 4

2012 HRRR (red curve) vs. 2011 HRRR (blue curve) bias score (X 100) as a function of forecast length for 25 dBZ radar reflectivity threshold, up-scaled to a 40-km grid.

Evident in Fig. 4 is a significant improvement in the bias for the 2012 HRRR compared to the 2011 HRRR, especially during the first 4-6 hours. This reflects the significant reduction in the overpediction of convective coverage and prediction of spurious convection in the 2012 HRRR compared to the 2011 HRRR.

4. 2012 HRRR CASE STUDY EXAMPLE

An impressive example of the ability of the 2012 HRRR to predict bow echoes is shown in Fig. 4, the 12-h HRRR forecast of the devastating Ohio Valley – Mid-Atlantic derecho that occurred in June 29, 2012. Widespread damaging winds from this event disrupted air travel and caused significant damage across many states. Especially hard hit was the Washington D.C. metropolitan area. As can be seen in the fig., the 12-h HRRR does an excellent job of capturing the derecho with excellent location and structure. This event posed a difficult forecast challenge and many storm resolving models produced very poor forecasts of the event.

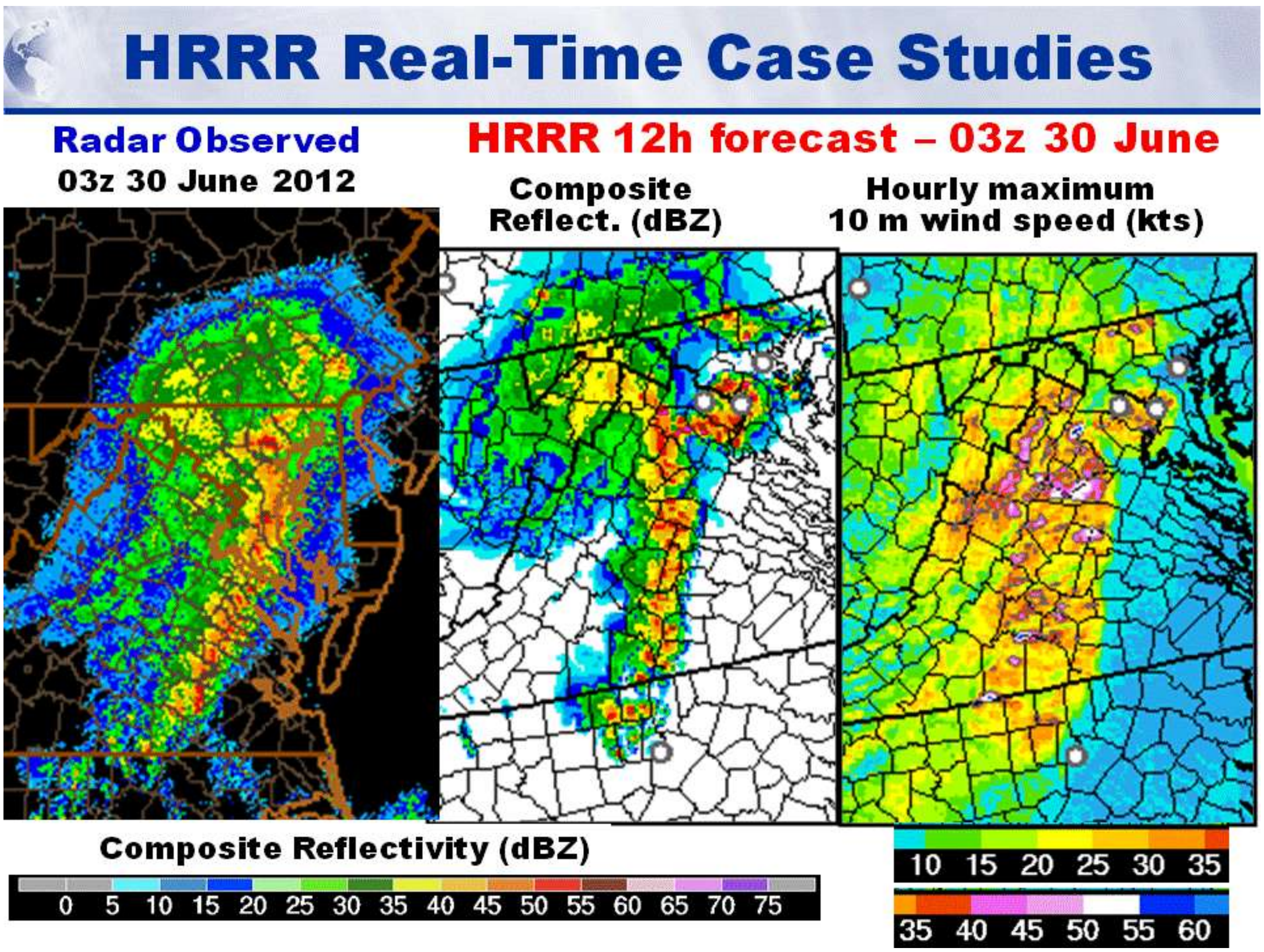

Fig. 5 Observed radar reflectivity at 03z 30 June 2012 (left) and 12-h HRRR forecast radar reflectivity (center) and hourly maximum surface wind speed (right) valid 03z 30m June 2012.